



Energy+Environmental Economics



RESOLVE Inputs & Assumptions Discussion

MAG Meeting #4
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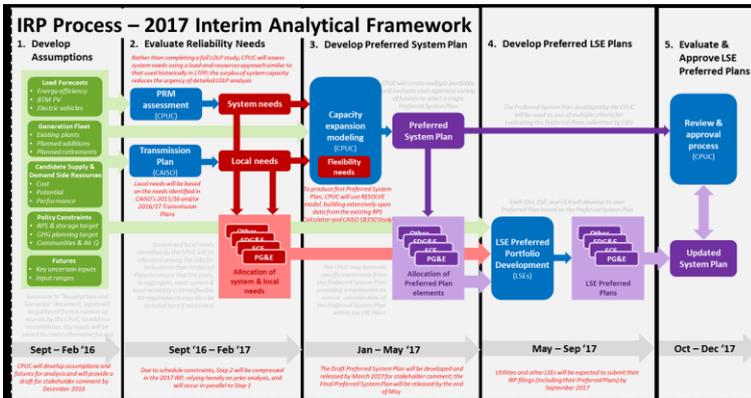
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Key Model Inputs

+ RESOLVE requires detailed inputs on both the demand side (load forecasts, load modifiers, candidate resources) and supply side (existing resources, candidate resources)



Load Forecast
The CEC's IEPR will be the primary source for the load forecast, supplemented if necessary with additional inputs as needed to develop alternative futures

- Energy Demand
- Energy Efficiency
- Behind-the-Meter PV
- Electric Vehicles

Load & Renewable Profiles
A library of hourly profiles will be gathered from multiple sources, including the CPUC's RA program (load) and NREL's WIND and SIND Toolkits (wind and solar)

- Load
- Solar PV
- Wind

Generation Fleet
A representation of the characteristics of existing and planned resources—as well as expected retirements—will be required for optimization of the system-level portfolio; possible sources include databases of WECC

- Operating Parameters**
- Max capacity
 - Min stable level
 - Ramp rates
 - Variable O&M
 - Heat rate
 - Start cost
 - Energy budget
 - Outage rates
 - Others...

Candidate Resources
The parameters characterizing candidate resources for inclusion in the Preferred Plan will be gathered from a variety of sources, including the RPS Calculator (renewables) and the LBNL DR Potential Study (demand response); where additional information is needed, it will be developed by CPUC staff

- Cost Parameters
- Financing Assumptions
- Resource Potential
- Performance

Price Forecasts
The CEC's IEPR will be used as the source for fuel and carbon price forecasts

- Fuel Prices
- Carbon Price

Policy Constraints
Policy constraints reflecting statutory requirements will be included

- RPS Target
- GHG Planning Target
- Storage Mandate
- Disadv Comm. & Air Q



Materials Provided to Parties

+ Draft IRP Assumptions Sources

- Word document summarizing key proposed sources of inputs to IRP modeling

+ Draft IRP Assumptions Values

- Excel spreadsheet containing data and assumptions needed as inputs to RESOLVE
- Generally aligned with Draft IRP Assumptions Sources—but may be some inconsistencies
- Also will function as User Interface for RESOLVE model when publicly released



RESOLVE Inputs: Table of Contents

+ RESOLVE's inputs are organized into groupings of tabs that indicate their content:

- **System:** characteristics and constraints on the CAISO system
- **Loads:** forecasts and attributes of load and load modifiers
- **Renewables:** inputs & assumptions on existing and candidate renewable resources
- **Conventional:** inputs & assumptions for existing and candidate conventional generators
- **Hydro:** characterization of hydro resources
- **DR:** characterization of conventional & advanced DR resources
- **Storage:** inputs and assumptions for existing and candidate storage resources
- **Costs:** fixed cost calculation module used to calculate levelized fixed costs of all candidate resources



Questions & Comments?

- + **Technical clarifications or corrections**
- + **Alternative suggested data sources**
- + **Role of specific assumptions in RESOLVE model**



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Thank You!

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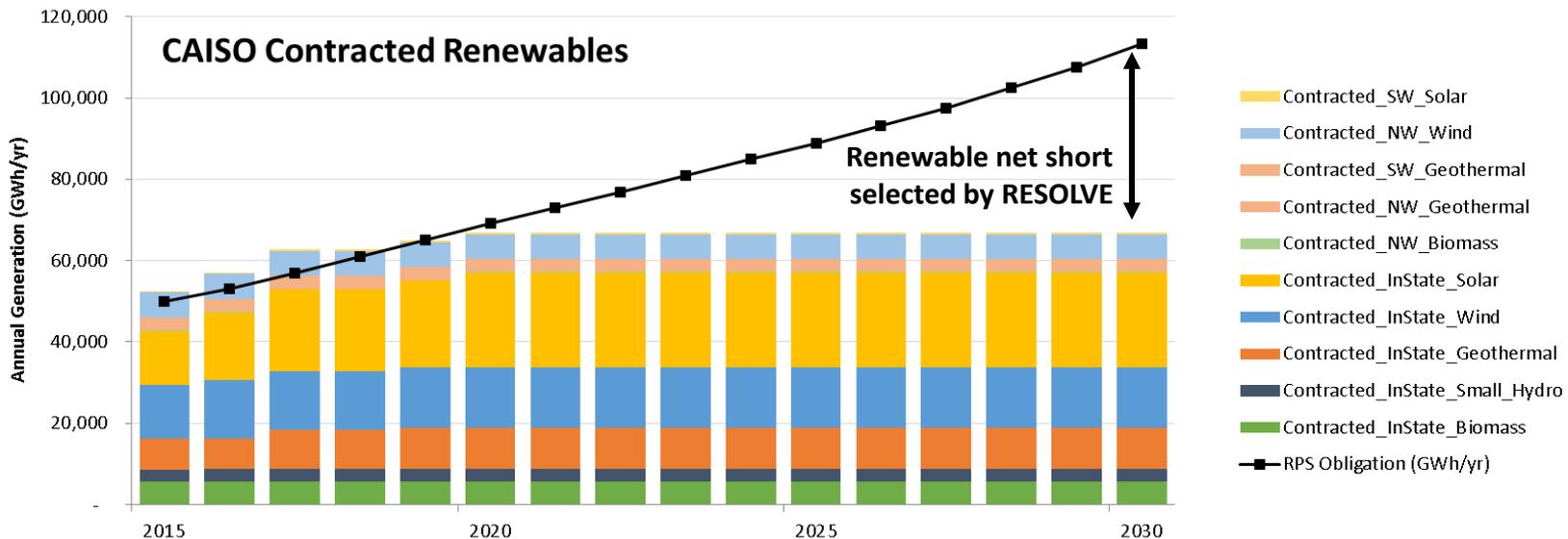
ADDITIONAL SLIDES

(FROM 12-16-16 WORKSHOP)



Renewables Portfolio Standard

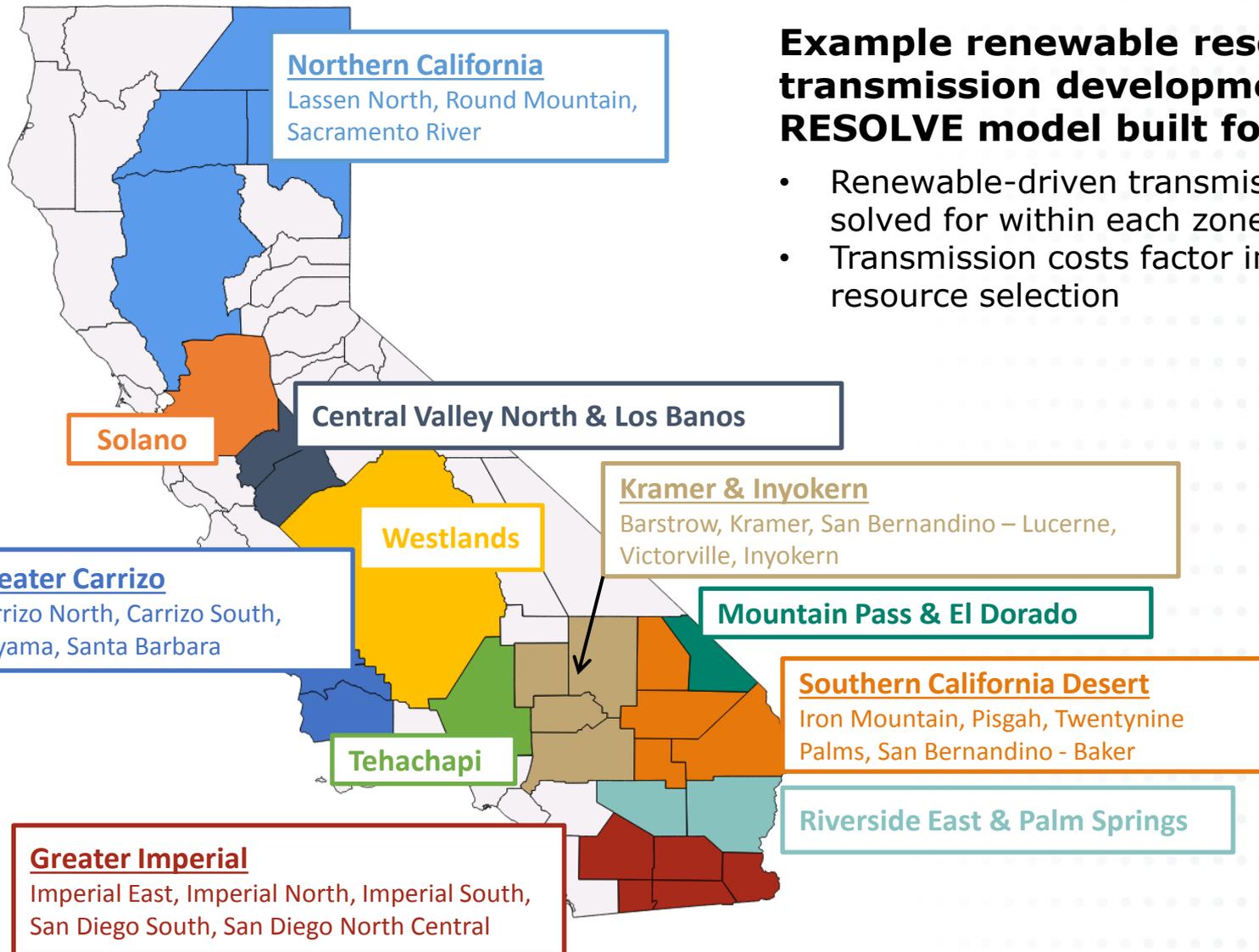
+ RESOLVE selects new resources to meet a renewable net short in each year



+ RPS constraint is based on delivered renewable energy, so renewable portfolio is “overbuilt” to offset for potential generation lost to curtailment



Renewable Resource Technical Potential



Example renewable resource and transmission development zones in RESOLVE model built for CAISO

- Renewable-driven transmission build solved for within each zone
- Transmission costs factor into optimal resource selection



System Operating Requirements

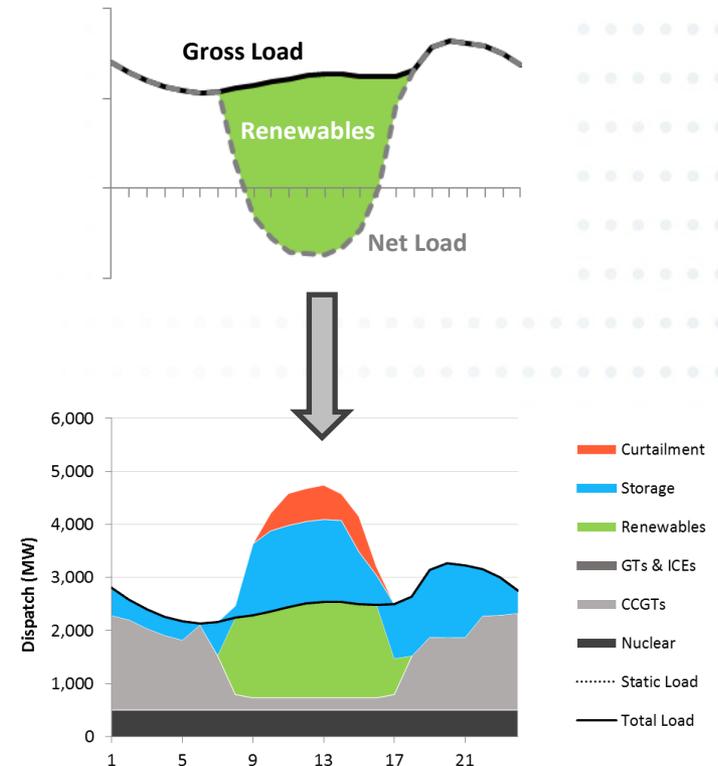
+ System operating costs included in objective function using a linear (LP) production cost model

- Zonal representation of WECC region with transmission constraints

+ Additional operational requirements are imposed to reflect CAISO operations:

- Spinning reserves
- Load following reserves
- Regulation reserves
- Frequency response

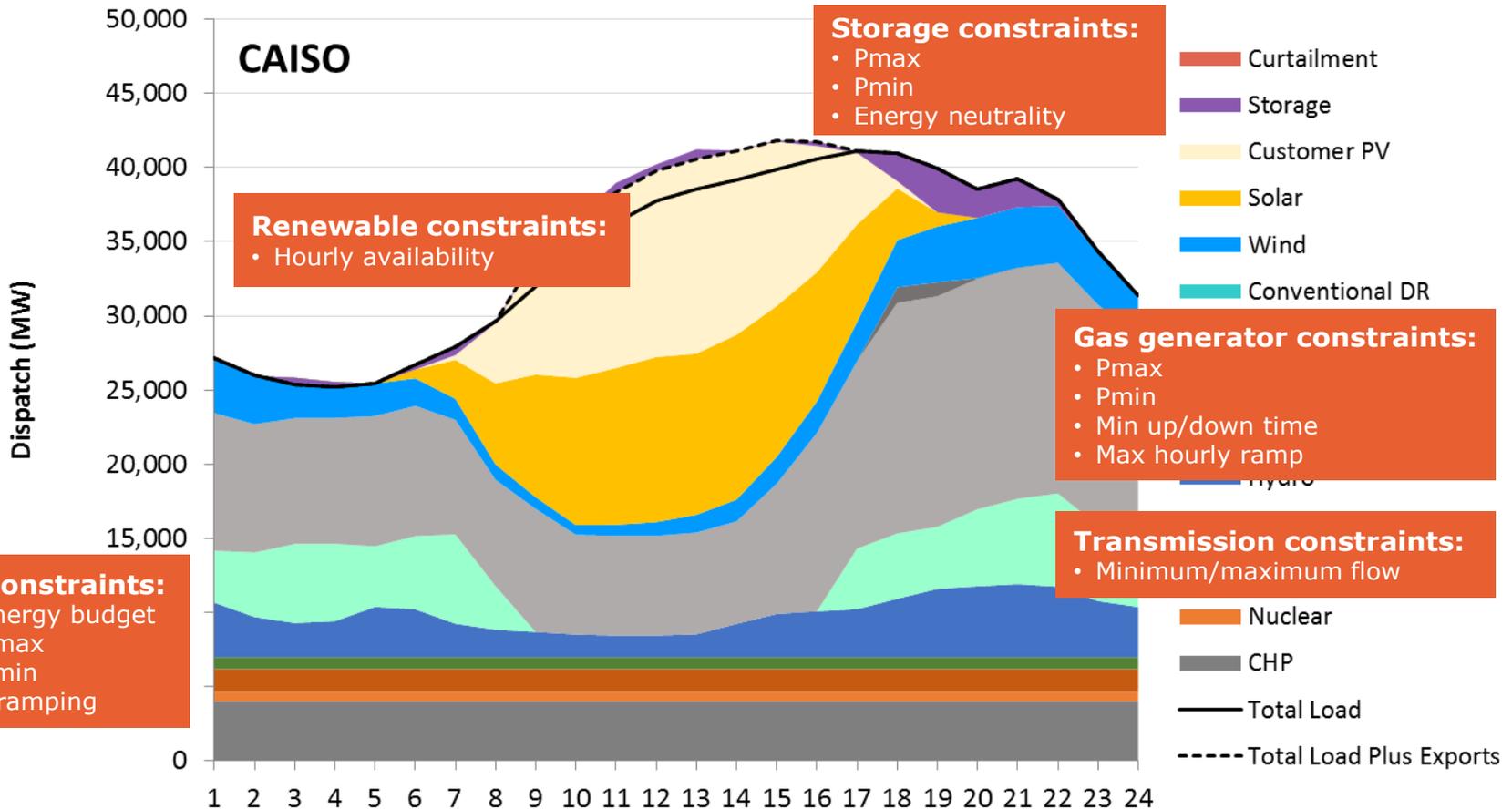
Captures operational impacts of renewable integration challenges





Plant Operational Constraints

+ Hourly operations is constrained by many factors:





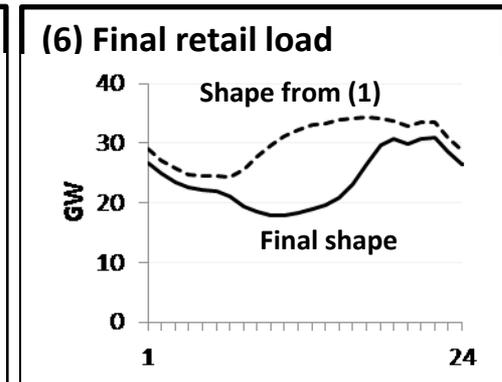
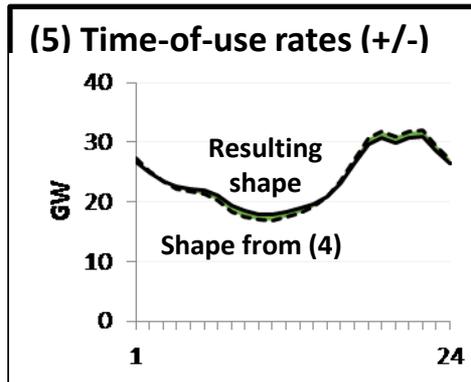
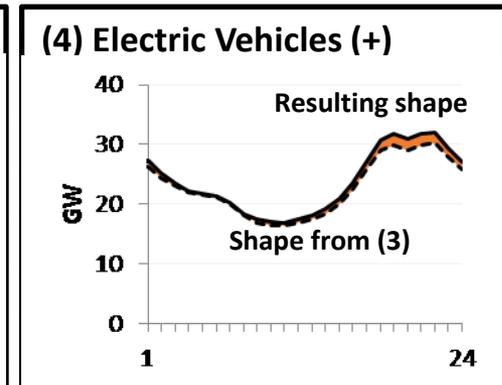
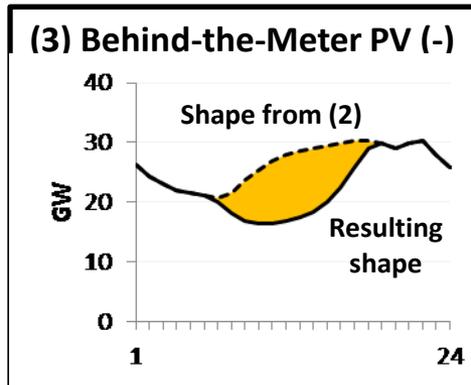
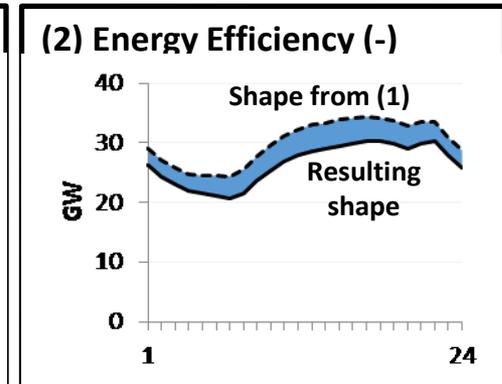
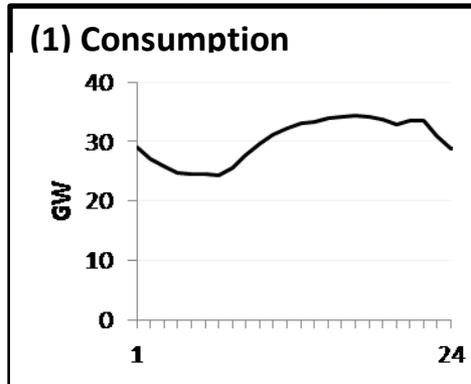
Load Forecast by Component

+ Load forecast incorporates multiple demand-side adjustments:

- Energy efficiency
- Behind-the-meter PV
- Electric vehicles
- Time-of-use rates

+ Each adjustment is modeled with an independent profile, allowing RESOLVE to capture changes in the load shape through time

+ Primary data source: [CEC IEPR Demand Forecast](#)

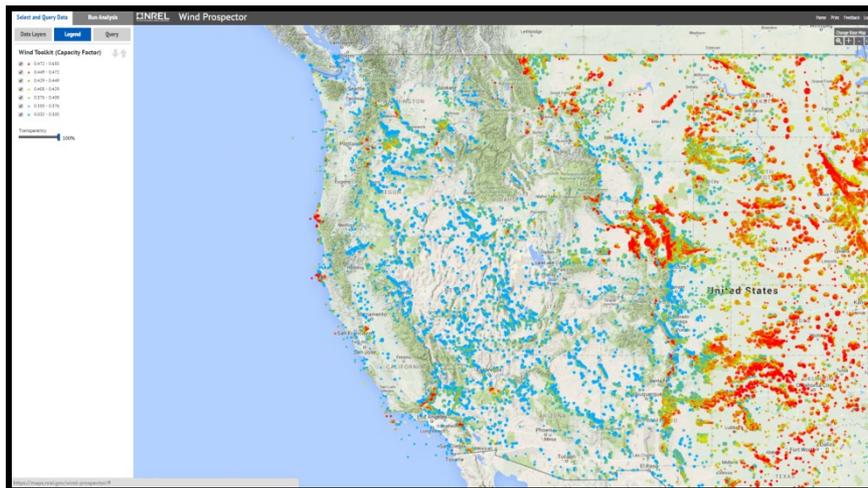




Load and Renewable Profiles

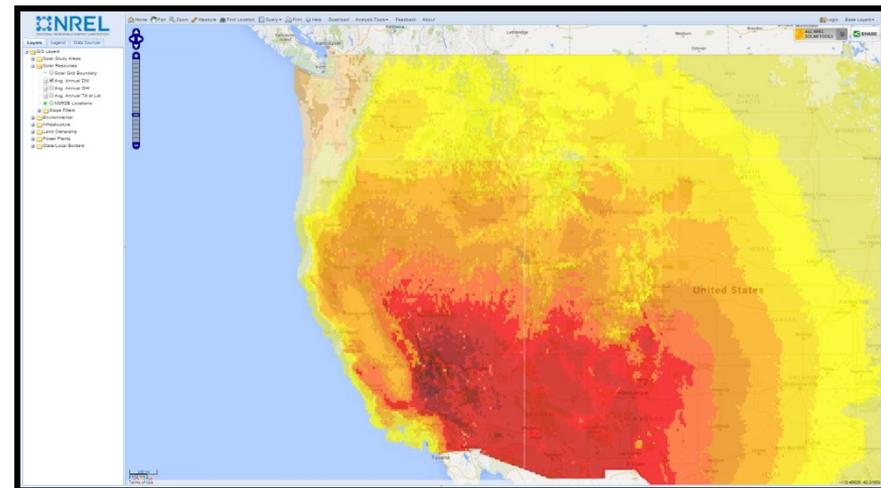
- + Load shapes for CAISO and other WECC BAs based on 2007-2009 historical period
- + Renewable shapes derived from NREL's latest wind and solar data sets:

NREL Wind Prospector ([link](#))



- 126,000 sites
- 5-min temporal resolution
- 2007-2013 historical period

NREL Solar Prospector ([link](#))

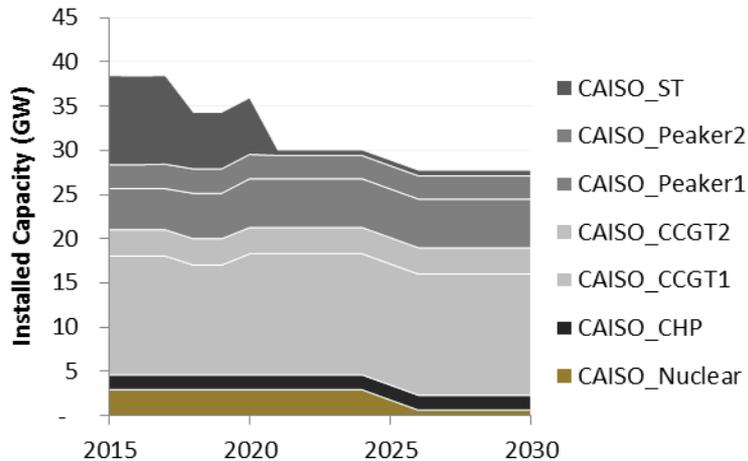


- 120,000 sites
- 1-min temporal resolution
- 2007-2013 historical period

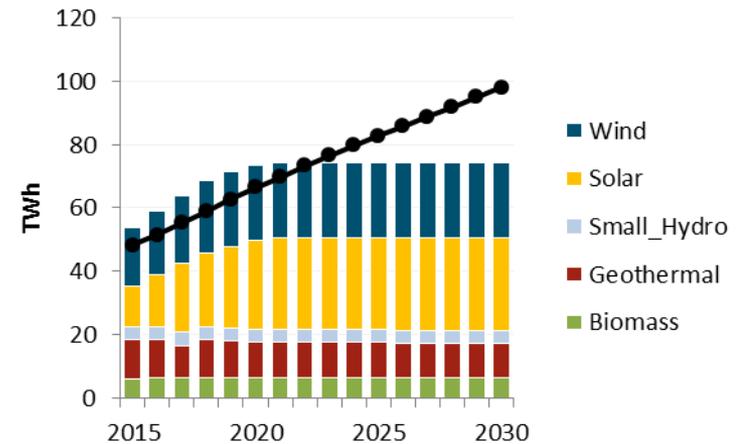


Existing Generation Resources

Existing & Planned CAISO Conventional Fleet



Existing & Planned CAISO Renewable Portfolio



+ Primary sources:

- CAISO conventional generators: [CPUC NQC list](#)
- Non-CAISO generators: [TEPPC 2026 Common Case](#)
- CAISO existing renewables: [CPUC IOU Contract Database](#)



Resource Cost & Potential

- + **For each candidate resource, RESOLVE requires input assumptions to specify:**
 - **Technical potential (MW):** total available resource that may be selected
 - **Fixed costs (\$/kW-yr):** annualized cost of investment + ongoing maintenance
 - **Operating characteristics:** e.g. hourly profiles for variable resources; operational constraints & variable costs for thermal & storage resources

- + **Primary sources:**
 - Renewables: [RPS Calculator Cost & Potential Assessment \(Black & Veatch\)](#)
 - Gas generation: [California Cost of Generation \(CEC\)](#)
 - Advanced DR: [2015 California Demand Response Potential Study \(LBNL\)](#)
 - Storage: [market research \(E3\)](#)